



Activity 1

Deadly Disease Among Us

Focus: Students complete a short “surprising statistics” quiz on the impact of infectious diseases, then classify several diseases as “emerging,” “re-emerging,” or “endemic.”

Major Concepts: Infectious diseases continue to be a major cause of human suffering and death, both in the United States and around the world. Emerging infectious diseases are diseases that have not occurred in humans before or that occurred only in small numbers in isolated places. Re-emerging infectious diseases are diseases that once were major health problems globally or in a particular country, and then declined dramatically, but are again becoming health problems for a significant proportion of the population.

Objectives: After completing this activity, students will

- recognize that infectious diseases are a continuing problem among all human populations,
- be able to define and give examples of emerging infectious diseases, and
- be able to define and give examples of re-emerging infectious diseases.

Prerequisite Knowledge: Students should be familiar with bacteria and viruses and understand that infectious diseases are due to infection of the body by an external agent.

Basic Science-Public Health Connection: This opening activity introduces emerging and re-emerging infectious diseases as a public health issue that can be examined using the methods of science (for example, collecting and organizing data into categories).

In developing countries where much of the population lives in conditions of extreme poverty, infectious diseases remain the leading cause of death. In the United States, prevention and control of infectious diseases have been so successful in the past half century that many people view infectious diseases as either a thing of the past or minor illnesses easily treated and cured, except among the very young, very old, or seriously ill.

In recent years, however, Americans have been shocked by the emergence of a variety of “new” infectious diseases. For example, *Escherichia coli* strain 0157:H7 caused severe vomiting and diarrhea among patrons of Jack in the Box restaurants in Washington State in 1993 and among children swimming in public pools in Atlanta, Georgia, in 1998. And a previously unrecognized virus (a hantavirus) caused a frequently fatal respiratory illness among apparently healthy young people in the Southwest. New diseases have emerged in developing countries as well. Ebola hemorrhagic fever, which was first described in 1976 in Zaire (now the

At a Glance

Introduction

Democratic Republic of the Congo), has particularly horrifying symptoms and a fatality rate of 50 to 90 percent. And AIDS, which emerged simultaneously in the United States and Africa in the early 1980s, has become a global pandemic.

Likewise, many diseases thought to be adequately controlled appear to be making a “comeback.” In developed countries, public health measures such as sanitation, sewage treatment, vaccination programs, and access to good medical care including a wide range of antibiotics have virtually eliminated “traditional” diseases such as diphtheria, whooping cough, and tuberculosis. However, many of these diseases are becoming a public health problem once again, as immunization programs and other public health standards are enforced less vigorously and, especially, as antibiotic-resistant pathogens evolve. In fact, medical workers have identified strains of pneumonia-causing *Staphylococcus aureus* that are resistant to all of the currently available drug treatments, and physicians and public health workers are concerned that we are about to re-enter the preantibiotic era for treating such diseases. Among the diseases “re-emerging” as a consequence of microbial resistance are tuberculosis and malaria, leading causes of death from infectious diseases worldwide.

This activity engages students in the seriousness of infectious diseases by helping them become aware of the widespread impact of such diseases. Students discover that some diseases are relatively new to humankind (emerging diseases), while others that had been nearly eliminated in developed countries are now beginning to increase in incidence (re-emerging diseases). They also learn that many diseases have been a perennial problem in human populations, never significantly declining (endemic diseases).

Materials and Preparation

You will need to prepare the following materials before conducting this activity:

- Master 1.1, *Causes of Death Quiz* (make 1 transparency)
- Master 1.2, *Disease Cards* (make a classroom set)

To make the disease cards, copy Master 1.2 and cut the copy apart to form individual cards. Glue each card to a 5 × 7 index card.

- Master 1.3, *Disease Classifications* (make 1 transparency)
- red transparency pen

Note to teachers: Activity 3 includes a bacterial growth experiment. If you are teaching the activities on consecutive days, students will need to complete Steps 5 to 8 on Master 3.1a, *Bacterial Growth Experiment*, during this class session. See Master 3.1a for details.

Procedure

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1. Introduce the module and this activity by asking students, “What disease do you think is the greatest threat to students in this class? What disease do you think is the greatest threat to the world’s population?” Solicit several responses and entertain a brief discussion about the diseases students perceive as threats and why.

List students' responses on the board or a transparency.

Heart disease was the top killer globally in 1998. AIDS and cancer are likely to be two of the top threats students perceive. According to the World Health Organization (WHO), in 1998 AIDS was the fourth highest killer worldwide, while cancer of the trachea, bronchus, or lung was the ninth highest killer. Also in the top 10 killers globally were cerebrovascular disease (second), pneumonia (third), chronic obstructive pulmonary disease (fifth), diarrheal diseases such as cholera (sixth), perinatal conditions (seventh), tuberculosis (eighth), and traffic accidents (tenth).

2. **Tell students that, as a class, they will take a quiz on some past and current causes of death and illness. Explain that you do not expect them to know the answers to these questions, but ask them to make well-reasoned guesses based on what they do know. Then display a transparency of Master 1.1, *Causes of Death Quiz*, solicit students' answers to each item, and provide the correct answers.**

If you have the equipment to project the video *Infectious Disease Then and Now* on the CD-ROM for the whole class, you can substitute this video for the quiz. Follow the instructions on page 31 to load the CD-ROM into the computer you will use. The video covers roughly the same content and may take less time than the quiz. Both the quiz and the video serve an engage role for this activity and the module.

Question 1 Which of the following diseases has been recognized since antiquity?

(c) Guinea worm disease, or dracunculiasis, is mentioned in biblical texts. Although it is unfamiliar to Americans, it is not uncommon on the Arabian peninsula and sub-Saharan Africa. The disease is caused by a parasitic roundworm that is ingested in a larval form. The larvae migrate through the tissues where they mate and grow. A year after they are ingested, the mature female migrates to subcutaneous regions, typically in the legs and feet. The worm may reach a yard in length. Its migrations cause great pain and inflammation, a burning itch, and subcutaneous ulcers. One form of treatment is to wet the skin to stimulate the worm to stick its head out and catch the head in a split stick. The worm is then slowly extracted, over the course of several weeks, by rolling it around the stick (if it is pulled too quickly, the worm will break in two, causing greater problems). This treatment may be the origin of the caduceus symbol that represents the medical profession. Students will learn as they complete this activity that Legionnaire disease and Ebola fever were first recognized as distinct diseases in 1976, and AIDS first came to worldwide attention in the early 1980s.

Question 2 In the 1700s and 1800s, a terrible, wasting disease killed thousands of European and American city dwellers. What disease was this?

(d) Tuberculosis (TB) killed 1 of every 4 Americans in the 1800s. The disease is still a leading killer globally, although it had decreased dramatically in the United States until the AIDS epidemic. The immune system of most people who contract the bacterium that causes tuberculosis successfully prevents its growth and active disease never develops. Any condition that compromises the immune system, such as HIV infection, will allow the bacteria to grow, resulting in active tuberculosis.

Question 3 What infectious disease causing severe fever and chills plagued settlers in the Southern and Midwestern United States during the 1800s and early 1900s?

(c) Malaria is thought to have been introduced to the United States from Europe and Africa in the 16th and 17th centuries. The incidence of malaria in this country probably peaked around 1875. In a review of U.S. malaria outbreaks, J. Zucker estimated that more than 600,000 cases occurred in 1914. Improved socioeconomic conditions, mosquito control measures, and availability of effective drugs later led to the virtual elimination of this disease in the United States, although localized outbreaks are still occasionally reported.

Question 4 Most deaths among U.S. servicemen in 1918 were due to what cause?

(b) Flu caused most of these deaths. The global influenza epidemic of 1918 is estimated to have killed 30 million people. The movement of troops during World War I, accompanied by crowding, poor nutrition, and generally poor living conditions probably contributed to the rapid spread of the flu around the world. The 1918 flu was particularly virulent and, unlike typical flu epidemics, caused death more frequently among young adults than among children and the elderly.

Question 5 In 1994, a terrible disease nearly killed an 18-year-old high school student in California. Which of the following diseases was it?

(d) Tuberculosis (TB). The student contracted TB from a classmate at her high school, who had an active, misdiagnosed case of the disease. An additional 11 students at her school developed active cases of TB, and several hundred more had positive skin tests indicating that they had been exposed. The student tells her story in Activity 3, *Superbugs: An Evolving Concern*.

Question 6 According to the World Health Organization, which of the following diseases caused more deaths in 1998 than the others?

(d) Pneumonia was the third highest killer in 1998, behind heart disease and cerebrovascular disease.

3. Explain that the quiz emphasized the impact of infectious diseases on people's health and well-being. Point out that even though medical advances in the last century have resulted in far fewer deaths from infectious diseases than at any other time in history, those diseases are still the leading cause of death worldwide and the third leading cause of death in the United States. Explain that in this activity they will learn about some infectious diseases that cause problems in the world today.

You may need to distinguish *infectious* diseases from *noninfectious* diseases. Ask students to review the *Causes of Death Quiz* and identify some of the infectious and noninfectious diseases listed there. If necessary, point out that noninfectious diseases such as cancer, heart disease, and cystic fibrosis cannot be “caught,” and that infectious diseases such as AIDS and tuberculosis are caused by living (or quasi-living, in the case of viruses and prions) agents that can be transmitted from one individual to another.

Identifying a disease as “infectious” or “noninfectious” has recently become more complex than it used to be. Researchers have discovered that infectious agents may play a role in some diseases that were previously considered noninfectious, chronic conditions. For example, there is evidence that gastric ulcers are caused by *Helicobacter pylori* bacteria. Similarly, infection by *Chlamydia pneumoniae* may contribute to the development of cardiovascular disease, leading some people to question whether heart disease might be infectious.

4. Organize students in teams of three and distribute five *Disease Cards* made from Master 1.2 to each team.

Distribute the cards in such a way that each disease is reviewed by at least one team.

5. Explain that scientists find it useful to group diseases in different ways, depending on the problems they want to address. As an example, display the first classification criterion on Master 1.3, *Disease Classifications*, and direct the teams to review their disease cards and sort them into piles that represent different types of infectious agents.

An important science process skill is identifying commonalities and differences and devising classification systems. In this step, students have the opportunity to practice this skill, and in Steps 7, 9, and 10 they consider the usefulness of classifying diseases in various ways.

6. Solicit titles for the categories identified from several teams and write them on the appropriate place on *Disease Classifications*. Then, ask the other teams to name one or more diseases they classified in the categories and write these into the appropriate columns. Ask students to describe the symptoms of each disease as they do so.



Circulate among the teams while they categorize their diseases in Steps 5, 8, and 10 for an informal assessment of students' skills in organizing information.



The discussion in Steps 7 and 9 are opportunities to point out the contribution of basic research to the development of effective treatments and preventive measures for many diseases. For example, research on the life cycle of *Schistosoma* identified snails as an intermediate host, revealing an important point for preventive measures. Scientists also recently discovered a drug that kills adult schistosomes, reducing the possibility of severe liver disease and interrupting the organism's reproductive cycle. Continuing research likely will lead to effective treatment and preventive measures in the future for diseases like AIDS that are currently incurable.

7. Ask students to suggest reasons why scientists might find it *useful* to classify diseases based on the type of infectious agent.

If students need help with this, ask them to review the treatment for each of the diseases within a category and the evidence (symptoms) that occur in each. Students should notice that diseases caused by the same type of infectious agent tend to have similar types of treatment strategies, and that similar symptoms occur in diseases caused by different types of agents. It is useful to classify diseases by the type of infectious agent because that indicates the type of treatment that may be effective better than does a review of symptoms.

8. Reveal the next classification criterion on *Disease Classifications* and ask students to re-sort their disease cards based on this criterion (the mechanism of transmission for each disease).

9. Repeat Steps 6 and 7 for this criterion.

It is useful to classify diseases by the way they are transmitted because a disease's mode of transmission may suggest an effective preventive measure. For example, the spread of diseases such as AIDS and Ebola hemorrhagic fever that are transmitted by intimate contact can be stopped or reduced through education and elimination of some behaviors (such as burial practices in which family members disembowel the deceased in nonsterile conditions) and institution of other behaviors (such as proper disease control measures in hospitals). The spread of vector-borne diseases such as malaria can be prevented by measures that reduce the size of the vector population or that limit contact between humans and the vector.

10. Reveal the last classification criterion, history of the occurrence of the disease, and repeat Steps 5, 6, and 7.

Students likely will identify two categories: "new" (for example, AIDS, Ebola, and Legionnaire disease) and "old" (for example, strep throat, guinea worm disease, pneumonia, polio, and tuberculosis).

If this is the case, fill these headings into the first two columns on *Disease Classifications* and list the diseases named by students. Then challenge them to re-examine the "old" diseases they listed and to subdivide that category. Assist them by asking a question such as "Is there any difference in the history of the 'old' disease tuberculosis and the 'old' disease pneumonia?" When students make the appropriate distinction, add the new headings for the second and third columns on *Disease Classifications* and relist the diseases accordingly.

Students should note that whereas all of the old diseases are described as "present from antiquity," the incidence of some of them has increased recently (in particular, the incidence of some has increased recently after declining in the past). The two categories from the subdivided "old" category could be renamed "Old and Increasing" and "Old and Remaining Constant."

11. Supply the labels “Emerging” for the apparently new diseases, “Re-emerging” for diseases that have recently increased in incidence after a decline, and “Endemic” for diseases that have remained relatively constant in incidence. Write these labels at the heads of the appropriate columns.

The disease cards provide examples of all three types of diseases, as shown in Figure 17.

Both polio and guinea worm disease are diseases that have declined dramatically and, hopefully, are on their way to global eradication. Cholera and influenza are more complicated examples that are less easily classified. Based on the information on their cards, students will likely classify cholera as a re-emerging disease and influenza as an endemic disease. Depending on the sophistication of your students and the time available, you may simply accept their initial categorization or you may choose to share the additional information below and ask them where they would categorize these two diseases. In either case, note that the categorization of infectious diseases into these three areas is somewhat subjective, and different researchers may categorize them differently based on the weight they give to various characteristics.

Cholera may be classified as either re-emerging because of increasing incidence due to the spread of the disease to Africa, or emerging because of the appearance of the new strain *Vibrio cholerae* 0139. This strain combines the greater virulence of the classic *V. cholerae* strain with the long-term survivability of the *V. cholerae* strain called El Tor.

Influenza is probably most accurately classified as an emerging disease because, although the flu occurs every year, each strain of the influenza virus is genetically distinct. In this sense, it is a constantly emerging pathogen.

You may also want to elaborate on the definition of emerging diseases by noting that this category includes (1) diseases that are truly “new” among humans (few, if any, examples fall into this subcategory); (2) diseases that probably affected a few individuals even hundreds and thousands of years ago, but have just recently affected enough of the population that they are noticed (AIDS and Ebola hemorrhagic fever are examples for this subcategory); and (3) diseases that affected people hundreds and thousands of years ago, but have just recently



This step focuses students' attention on the major concept of this activity and the module: Infectious diseases are an increasing health concern in part due to emerging and re-emerging diseases.

Figure 17 History of Occurrence

Emerging Diseases	Re-emerging Diseases	Endemic Diseases
AIDS, cholera, CJD, Ebola hemorrhagic fever, influenza, Legionnaire disease, Lyme disease	tuberculosis, malaria, schistosomiasis	pneumonia, polio, guinea worm disease, plague, strep throat

been recognized as due to an infectious pathogen (gastric ulcers caused by *Helicobacter pylori* is an example that falls into this subcategory). Many researchers include re-emerging diseases as a subcategory of emerging diseases.

- 12. Conclude the activity by telling students that public health workers are becoming increasingly concerned about the emergence of “new” diseases and the re-emergence of some “old” diseases. These biologists have found it useful to classify infectious diseases as emerging, re-emerging, or endemic because there tend to be different factors related to each category. Tell students that they will explore factors related to disease emergence and re-emergence in upcoming activities.**

Potential Extensions

Internet Web sites maintained by both the Centers for Disease Control and Prevention (www.cdc.gov/) and the World Health Organization (www.who.org/) include health topic sections that provide information on infectious (and noninfectious) diseases. Assign students to use these and other resources to create additional disease cards and to classify those diseases as emerging, re-emerging, or endemic.